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naphtha, of which there is an extensive consumption in the countries bordering on the Caspian, the lower classes commonly burning it in their lamps. It is extremely cheap, a maun shakee, or 13 lbs., being worth at Enzilli 12 to 14 shahees, or about 8*d.* sterling.

The Russian mercantile marine in the Caspian is said to amount to about 1000 vessels of all descriptions: the limited trade of this sea not requiring so many, freights are exceedingly low.

The village of Peeree Bazaar, the shipping-place of all goods passing between Resht and Enzilli, is situated on a small river at about 3 miles from the lake. It possesses neither stores for goods nor accommodation for travellers; the only shelter to be obtained for the former is an open shed, which hardly screens them from the weather. Here they have to await the chance arrival of boats from Enzilli, which come generally only when they have obtained a lading. The road from Peeree Bazaar to Resht lies through the jungle, and, if road it may be called, can scarce be exceeded in badness by anything with such a name. Though the actual distance is perhaps not more than 5 or 6 miles, such is the extreme difficulty of the road, that it requires 3 to 4 hours to perform it with a horse lightly burthened. The river of Mân-gaudeh, a small stream about 12 yards wide, which passes near Resht, and falls into the lake, offers an easy channel of communication with Enzilli; but the same reasons which induce the government to neglect the repairs of the Peeree Bazaar road, render it also their policy to impede the free navigation of this little stream, which, from want of attention, has its course blocked up in various parts by fallen trees and mudbanks. In summer, when the water is low, on account of these obstructions boats cannot ascend the stream, I believe; and in winter the current is so strong, that it takes a day to ascend from the lake to near Resht, a distance of about 10 miles.

In conclusion, I would observe that Ghilan, though in wretched hands and kept in the most shameful state of neglect, is, in proportion to its extent, the richest province of Persia. Its inhabitants appear to possess a great deal of wealth. Among the highest classes there are large fortunes, and traders with 2000 to 5000 tomauns capital are very numerous. The lowest class, though not supposed generally to possess more in coin than they require to purchase necessities with, appear to live comfortably on half their crops of rice (the other half being the property of the landlord), their poultry, and the produce of their cows, together with the wild fruits which grow everywhere, and the fish of the numerous streams, the lake, and sea. The government derives a yearly revenue of 200,000 tomauns, or about 100,000*l.* sterling, from the province, including the customs and rent of the fisheries, which together amount to 45,000 tomauns, or about 22,500*l.*; but probably half as much again is paid in voluntary contributions by the principal people of the province to the court for objects of self-interest, and there are many pensioners in the province who have grants of lands and villages made them by government in return for services.

15. *Remarks on the Undulatory Motion of the Sea and its Currents.** By
Commendatore ALESSANDRO CIALDI.

FIVE principal propositions form the subject of the present notice:—

1st. The translation of the liquid mass in the undulating motion of the waves on the open sea when the wind is violent.

2nd. The absence of any notable translation in the said undulating mass when the velocity of the wind is not more than 7 or 8 mètres per second.†

* Cenni sul Moto ondoso del Mare, e sulle Correnti di Esso. 4°. Roma, 1856.

† Mètre = 39·37 inches.

3rd. The translation of the mass of the waves when they have not free scope underneath, although the wind is moderate.

4th. The number of mètres in depth to which the action of the waves is communicated.

5th. The superiority of the effects of the real motion of the waves over the littoral and tidal currents, with respect to the translation of detritus or obstructive materials.

From the general system of ideas developed by the author we gather that to attribute a motion to the liquid mass of waves is not conformable to the hydrodynamic principles generally established. Thus the propositions contained in his first, third, and fifth questions cannot be explained by the mechanical theory of fluids, but he demonstrates that this theory, often contradicted by experience, leaves much to be desired if applied to the undulating motion of the sea. To this effect the author has, in his *Introduction*, given a description of the hypotheses or theories promulgated by the distinguished authors who have preceded him, whence results such a variety of views as to give confidence in his own opinion. However, the author appears thoroughly convinced that the above theory is based upon truth. Thus, when extraordinary causes do not intervene, the elements established by that theory in the phenomenon are not altered, and consequently the latter acts according to the law established by the theory.

But when a cause like that of a violent and long-continued wind alters the pre-established system in the undulatory motion, the author cannot but admit a notable motion in the liquid mass. He holds it to be indisputable that the wind can communicate to the waves a real motion of translation on the surface of the water, and his conclusions are not deduced from experiments made in the quiet of the study, but from facts verified in the immensity of the sea. The author has therefore adduced a great number of such facts in the twelfth paragraph. Besides which, reason suggests to him that a liquid mass in equilibrium on one side, receiving continuous or intermittent impulses, must also receive continuous motions of translation from the opposite part. Now, if this argument and the whole series of facts collected are not sufficient to convince any one of the important influence that a given force of wind has upon the liquid mass, the author requires explanations of those extraordinary translations experienced by ships in certain latitudes where the current is known or where none exists (§ 13). The facts subsist; we feel the necessity of explaining them in order to prevent their fatal effects. But hitherto, as far as the author knows, no one has occupied himself sufficiently with this matter.

In consequence of the materials gathered in the twelfth paragraph, it was easy for the author to compile the contents of the thirteenth section; and the example of the English vessel *Winchester* and that of the French frigate *Venus*, adduced in the above paragraph, are for him a clear explanation of the sought-for cause of that extraordinary translation or drifting. The number of examples, says the author, might be considerably increased, but, in a paper bearing the simple title of 'Hints,' he thinks that what he has said on the subject in §§ 12 and 13 may prove sufficient. Now, if this proposition, which embraces the first question, somewhat differs from the theoretical law of the undulatory motion, seeing that the powerful causes in certain cases produce an alteration, he believes that, in these exceptional cases, the said proposition may be admitted among those which are tolerably proved, and therefore deserve to be seriously examined. When such exceptional causes do not exist, namely, when the wave is not struck by a wind stronger than seven mètres of velocity in a second of time, the author agrees with the theory, and therefore, in the second question, he does not admit a notable motion of translation in the waves, and he combats the contrary opinion of De Tesson, Alan

Stevenson, Paoli, and De Coligny ; and, in the 15th paragraph, he adduces a great number of facts to prove the mistake under which they labour. The author therefore drawing a marked distinction between the state of a wave driven by an impetuous wind and that of a wave acted on by a slight breeze, equally combats the views of those authors who deny that there is any motion of the particles of the liquid mass in waves, and those who always admit its existence.

Let us now pass on to the proposition which forms the subject of the third question. In the 19th paragraph the author begins to treat of the phenomena which must occur when the wave strikes the bottom of the sea with its base. The 20th paragraph describes this phenomenon, and the 21st shows its existence, deduced from a series of facts which he considers very conclusive. The hypothesis that in the wave raised by the wind near the shore the same thing may arise that occurs in the tidal wave (§ 21), seems to the author to have so much analogy and probability that he believes himself obliged to admit one of the following consequences : either that such hypothesis is the expression of what actually takes place in nature, or that the reality, whatever it may be, must be so nearly parallel to the truth as to admit of one mode of expression common to both.

It results therefore from what precedes, that if his proposition be not susceptible of any other explanation, it must be taken into consideration, otherwise we should form a very restricted idea (on the authority of Sir J. F. W. Herschel, says the author) of the merit and importance of the hypothesis ; but following the relation of facts, he gathers his conviction that the hypothesis by him presented amounts to a certainty. Nevertheless, he himself concludes that it would not be useless to collect a greater number of proofs in order to obtain universal assent to his convictions.

From the remaining part of the 21st paragraph the author prepares the arguments which are to serve him in supporting the proposition which forms the fifth and last question.

But before proceeding to it he stops to prove the volume and velocity of the waves, the depth to which their action is communicated, and what their power may be.

The coasts of islands and continents receive their configuration from the mass of waters in motion. Some distinguished authors assert that it results from the littoral or tidal currents ; whereas Mr. Cialdi believes that such configuration is the work of the waves. The paragraphs 22, 23, and 24, referring to a long series of analogous proofs, treat of the volume of the waves, their vigorous footing proving their immense power at depths hitherto not acknowledged by the learned, and induce the author to conclude that the waves are the principal instruments employed by nature in excavating and filling up the shores of the sea.* With this important series of facts the

* From the facts gathered by Mr. Cialdi it results that the waves can attain 11 mètres (36 feet English) in height, 20 mètres (66 feet) of velocity in one second of time, and 300 mètres (984 feet) of amplitude from crest to crest. Their power near the surface of the sea is of 30,000 kilogrammes per square mètre (6145 lbs. per square foot English) ; their action is communicated still perceptibly at the depth of 200 mètres (656 feet) ; and when arrived at a bottom of 34 mètres (111 feet) of water they break.

In the Mediterranean the waves attain only 9 mètres (29·5 feet) in height, 10 (32·8 feet) mètres of velocity in a second, and their power has been found, 7 mètres above the surface of the sea, to amount to 16,000 kilogrammes per square mètre (3265 lbs. per square foot), which is still perceptible at a depth of 60 mètres (197 feet). They begin in that sea to break when they meet the bottom at a depth less than 12 mètres (39 feet).

author undertakes to examine the doctrine of Montanari, and thus passes on to the *second part* of his work.

According to Mr. Cialdi, Montanari's doctrine considered *per se* is far from solid, and a small number of facts adduced would suffice to prove it erroneous. But that doctrine being supported by the most celebrated men who have treated the subject of the motion of waters, he feels the necessity of extreme circumspection in his deductions while unhesitatingly refuting the same. He therefore endeavours to enter gradually into the development of the question in hand, with the paragraphs from 25 to 35, and as he proceeds he gathers in new facts against the defenders of the said doctrine; so that at the 37th paragraph he seems to think that he has annihilated it by weight of the facts and by dictates of reason, and he sees rising on its ruins the new law of *sand-shiftings*, the principles of which were already indicated by Castelli, Boscowich, and De Fazio, but remained neglected on account of the prevailing theory of Montanari. This new law of sand-shifting is held by the author as an axiom.

The author was under this conviction when he became acquainted with the excellent 'Considerations on the *Protrusion* of Shores and on the Sand Accumulations in the Ports of the Adriatic, applied to the Establishment of a Port in the Pelusian Bay,' by the celebrated Paleocapa.

It is easy to perceive that, those 'Considerations' contradicting the two principal propositions which form the basis of almost the whole edifice raised by Captain Cialdi, he saw himself placed under the necessity either of renouncing the authority of all the facts adduced in his work, or of making an *appendix* to the same, which, based on the same facts and on others omitted for brevity's sake, should prove the exactness of his arguments. After mature reflection he adopted the second alternative; and we gather from the Appendix he has published that a more thorough examination of the question has given, according to his opinion, still greater evidence to all that he had previously enunciated.

In this Appendix he besides avails himself of the opportunity of adverting to the intended Pelusian port; he applies there his theory, and suggests a few modifications in the piers which are to form that harbour.
